CONTROL DEMONSTRATION OF THE RICEFIELD BREEDING MOSQUITO *ANOPHELES ACONITUS* DONITZ IN CENTRAL JAVA, USING *POECILIA RETICULATA* THROUGH COMMUNITY PARTICIPATION: 2. CULTURING, DISTRIBUTION AND USE OF FISH IN THE FIELD.

Sustriayu Nalim* and Damar Tribuwono*

A B S T R A K

Suatu percobaan pemberantasan vektor malaria *Anopheles aconitus* dengan penyebaran ikan pemakan jentik *Poecilia reticulata* di sawah telah dilakukan. Untuk memacu peran serta petani, penyebaran ikan *P. reticulata* dilakukan bersamaan dengan minapadi di mana ikan *Cyprinus carpio* dipelihara di sawah. Beberapa aspek yang diteliti dalam percobaan ini adalah (1) biologi jentik *An. aconitus* dan ikan dan (2) cara-cara berkembangbiaknya ikan. Penelitian ini menunjukkan bahwa penyebaran *An. aconitus* di sawah pada umumnya ½ – 1 meter dari tepi pematang sawah, daya makan ikan *P. reticulata* rata rata adalah 119,4 jentik/hari, daya reproduksi rata-rata ikan *P. reticulata* adalah 109,3 ikan/bulan, daya produksi ikan *C. carpio* berkisar antara 5000 – 10.000 telur/3 bulan tergantung pada umur ikan betina. Kepadatan ikan *P. reticulata* 2 ikan/m^2 dapat menanggulangi populasi jentik di sawah.

INTRODUCTION

A study was conducted to explore the feasibility of using the larvivorous fish *P. reticulata* in ricefields through community participation. Health education, demonstration in specific agricultural practices and fish breeding, coordination of local government officials have stimulated farmers participation[1].

Specific studies on the biology of *An. aconitus*, *P. reticulata* and *C. carpio* were conducted to reveal information on (1) densities and distribution of larvae in ricefields, (2) reproductive rates of *P. reticulata* and *C. carpio*. These particular information being used to calculate larvivorous fish required densities to suppress Anopheline densities in ricefields. In addition mass breeding techniques for *C. carpio* were also observed.

This paper reports the results obtained during observations made.

MATERIALS AND METHODS

Reproductive rates of *C. carpio* and *P. reticulata*.

C. carpio : One adult female fish and 3 male fish were kept in a pond for mating. After 3 days males were removed and the female remained in the pond until egg-laying. Ponds were provided with coconut bast for egg–laying. Eggs hatched within 24 – 48 hours after laying. The brood was counted after one month.

P. reticulata: To determine the reproductive rate of *Poecilia reticulata*, 10 one-month-old pregnant females were dissected and the number of young counted. Dissections were performed three times and the results averaged. To estimate the population derived from one female a hypothetical formula was used. When females are 2 months old it will reproduce every month. The estimated longevity is about 5 – 6 months.

* Puslit Ekologi Kesehatan, Badan Litbangkes.

Observation of larval densities and distribution.

The larval densities were determined by placing 20 emergence traps (see fig. 1) 50 cm x 50 cm x 120 cm in the ricefields. Traps were examined daily. Mosquitoes emerging in traps were collected and identified. To avoid depletion of larvae and creation of a microhabitat, traps were moved every three days. The traps are placed in the ricefields only during the planting season when fields are flooded, and removed when the ricefields are dried, approximately 3 weeks before harvest time. The number of mosquitoes collected per day per m^2 is calculated from the total number of mosquitoes collected in 20 traps per month and averaged for 1 year.

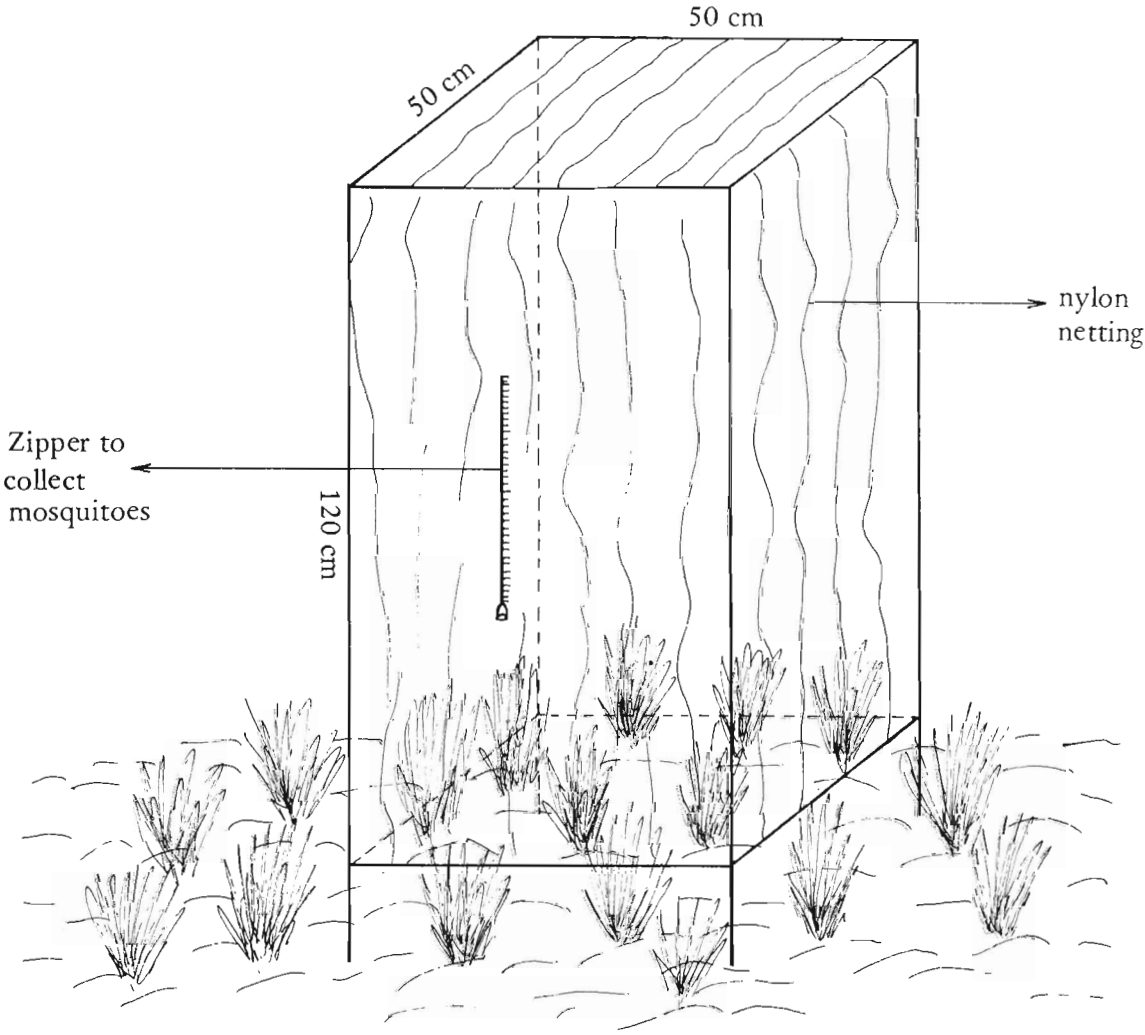

Fig. 1. Emergence trap used in ricefields for collection of mosquitoes emerging.

To determine larval distribution, 40 traps were set at random, 10 at ½ m, 10 at 1m, 10 at 2 m and 10 at 5 m distance from the ricefield edge. The traps were monitored and mosquito densities determined as in table II a.

Observations of larvivorous fish potential.

To determine the larvivorous potential of *P. reticulata* 10 simulated ricefield plots of 50 x 100 x 150 cm^2 were used. Two larvivorous fish species were used e.g. *P. reticulata* and *Aplocheilus panchax*.

However, a distinction was made between *P. reticulata* collected from Banjarnegara regency and *P. reticulata* from Temanggung regency. Every pond was seeded with 25 larvivorous fish (size 2 — 3 cm long) and every pond was supplied with 500 larvae at two hours interval. Two hours after the first distribution of larvae, 5 fishes taken from each pond were dissected. Disections were performed 2, 5, 7, 12 hours after the first seeding.

Larval remains detected were counted (mainly siphons). For each fish species and locality, 3 replicates were made. Data obtained was summarized for 4 hours, 6 hours and 12 hours after dissection and the total was calculated for 24 hours.

Calculation of *P. reticulata* required densities to obtain Anopheline larval suppression.

Larvivorous fish densities were determined by the larvivorous potential of fish and the average densities of mosquitoes trapped in the ricefield.

Assuming that the larvivorous potential is A/day and the number of mosquitoes collected/day is B., than the number of larvae will be 10 B (preliminary studies show that only 10% of first instar larvae will reach the adults stage). The densities of *P. reticulata* determined will be $\frac{10\ B}{A}$ fish.

Mass breeding techniques for *P. reticulata* and *C. carpio*.

C. carpio : Nine ponds of app. 2 x $4m^2$ were rented to start mass breeding of *C. carpio* for distribution to the farmers. Fourteen adult males and 19 adult females were used for mass breeding.

Males and females were gathered in ponds for mating every 3 months. Three days after being gathered in one pond, males were removed. Young fish were accumulated in one pond, counted and distributed to the farmers by the government fishery official.

Fish distributed to the farmers were at least 3 months old. Every batch approximately 100 young fish were kept for rejuvenation of adult stock.

P. reticulata: One pond of 5 x 1,5 m^2 was used for *P. reticulata* mass breeding. The pond was seeded with approximately 20,000 fish. *P. reticulata* was distributed to the farmers synchronous with *C. carpio*.

RESULTS AND DISCUSSION

Reproductive rates of *C. carpio* and *P. reticulata*.

C. carpio : Results obtained showed that *C. carpio* adults were most productive from 4 — 6 years old, laying an average of 7,500 — 10,000 eggs/female. At younger or older ages the numbers of eggs laid would decline varying from 3000 — 8000 eggs/female.

P. reticulata: Dissections of 2 and 3 month old fertile females revealed an average of 109.3 young. Results fluctua-

ted between 90 – 130 young per female (see Table 1).

Observations in the aquaria by other workers, revealed a maximum of 40 – 50 young per female[2]. However, in nature it was observed to give birth to 100 or more young[3].

The reproductive potential of the same female and it's offspring is calculated based on Table 1a. Based on this it was revealed that from one female, within a period of 5 months approximately 12,383.7 young can be generated.

However, causes of mortality were not considered since these calculations only provide a potential estimate.

trap was designed to trap mosquitoes emerging in the ricefields.

Emergence figures obtained from the traps are summarized in Table 2. Overall densities decreased from 13.65 mosquito/m^2/day in 1979 to 4.97 mosquito/m^2/day in 1984.

An. aconitus decreased from 3.35 mosquito/m^2/day to 0.01 mosquito/m^2/day, a decrease of 99.7%.

Details on the relationship between the decrease in *An. aconitus* densities and the malaria incidence is discussed elsewhere.

Results from emergence traps (see Fig. 1) placed at various distances from the riceplot edges show that 66.85% of

Tabel 1. Number of offspring generated from one female during 2 – 5 months (determined by dissections), calculated from table 1a.

# of offspring			
2 months	3 months	4 months	5 months
109.3	218.6	6,030.1	12,383.7

Tabel 1a. Calculated figure for viviparus fish reproduction.

Age of female fish in months	# of offspring
2	n
3	2n
4	$\frac{1}{2} n^2 + 3n$
5	$n^2 + 4n$

Anopheline densities and distribution

To determine mosquito densities emerging from the ricefield (direct impact of larvivorous fish release) an emergence

the mosquitoes collected is found ½m from the riceplot edge. Only 5.52% is found at 5m distance from riceplot edge (see Table 3). *An. aconitus* is mainly

Tabel 2. Mosquito emergence figures averaged per year (2 planting seasons).

Species	YEAR					
	1979*	1980	1981	1982	1983***	1984**
An. aconitus	3.35	0.4	0.2	0.1	0.2	0.01
An. barbirostris	1.13	0.7	0.7	0.51	0.7	0.5
An. annularis	3.35	2.25	1.13	0.7	1.02	7
Cx. fuscocephalus	0.12	0.7	0.7	0.4	0.5	0.4
Cx. vishnui	0.7	0.4	0.2	0.1	0.2	0.01
Cx. bitaeniorhynchus	5	5.07	4.35	3.35	4.35	3.35
Total	13.65	9.52	7.28	5.16	6.97	4.97

* mosq./traps/m/day. (1 trap = 0.25 m).
** observation discontinued March 1984 (1 planting season only).
*** long drought, *P. reticulata* reseeded.

Tabel 3. Emergence figures for mosquitoes collected at ½ m, 1m, 2m and 5 m distance from riceplot edges.

Month	Species	Total # of mosq. collected distance from plot edge				
		½ m	1 m	2m	5 m	Total
September	*Cx. bitaeniorhynchus*	34	15	10	5	64
	Cx. vishnui	3	1	1	–	5
	An. annularis	1	–	–	–	1
October	*Cx. bitaeniorhynchus*	69	10	7	5	91
	Cx. tritaeniorhynchus	1	–	–	–	1
	An. annularis	3	2	–	–	5
	An. aconitus	7	2	–	–	9
	An. barbirostris	3	1	1	–	5
Total		121	31	19	10	181

found at ½m @ 1m distance from the edge, and only *Cx. bitaeniorhynchus* is found emerging until 5m from the riceplot edge. *P. reticulata* is found in schools mostly close to the riceplot edges, especially close to open dikes where water flows into the ricefield. *An. aconitus* habitat seem to coincide well with the *P. reticulata* distribution.

Larvivorous potential of *P. reticulata*

Results obtained show that *P. reticulata* from the Temanggung regency seems to be the most potential fish for larval consumption at a rate of 119.4 larva/fish/24 hours (see Table 4). Based on these findings this particular strain was used for the biological control studies in ricefields. The maximum number of larvae detected in the fish gut content was 53.5 larvae/fish.

These results coincide well with results obtained by Menon and Rajagopalan[4] who observed an average of 53.1 larvae in *P. reticulata.*

Calculated *P. reticulata* required densities to obtain suppression of Anopheline larva.

Results obtained during one planting season (maximal density obtained from emergence trap figure) revealed an average density of 13.65 mosquito/m2/day (see Table 1).

Table 4 Larvivorous fish potential in simulated ricefield plots.

Hours after larval seeding	Fish species	# of siphons detected	Duration * of larval siphon in gut content	Cumulative figure for larvae consumed in 24 hours
4	*P. reticulata* (Temanggung)	26.1	0 – 5	
6		53.5	6 – 10	119.4
12		39.8	11 – 15	
4	*P. reticulata* (Banjarnegara)	24.7	0 – 5	
6		17.0	6 – 10	69.2
12		27.5	11 – 15	
4	*A. panchax*	10.3	0 – 5	
6		13.8	6 – 10	29.4
12		5.3	11 – 15	

* Observations showed that 5 hours after feeding no remains of larva could be detected in gut contents. Siphons or larval remains after each 4 hours are determined as newly ingested and added to the number of siphons detected in the first 4 hours.

The larvae consumed per fish was 119.4 larvae/fish/day. Based on calculations approximately 2 fish should be distributed per m^2.

SUMMARY

Biological studies performed revealed that :

- The majority of mosquito larvae breed in ricefields at ½m – 1m distance from the ricefield edge.
- *P. reticulata* is a potential larvivorous fish which reproduces relatively fast.
- Based on observation on mosquito densities in ricefields, densities of *P. reticulata* should be a minimum of 2 fish/m^2 to obtain control of mosquito larvae in ricefields.

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